U. S. Department of Agriculture
Agricultural Research Service
Entomology Research Branch
In cooperation with 15 cotton-growing States



# CONFERENCE REPORT

# ON

# COTTON INSECT RESEARCH AND CONTROL

Dallas, Texas, November 30 to December 1, 1954

(Eighth Annual Report)

Supplement to 1953 Report



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The eighth annual conference of State and Federal workers concerned with cotton-insect research and control was held at Dallas, Texas, from November 30 to December 1, 1954. The purpose of these conferences is to review the research and experience of the previous years and to use them as a guide in the preparation of cotton insect control recommendations for the following year. This year's report is issued as a supplement to the 1953 report. The sections on Insecticides and Miticides, pages 13-23, and Chemical Control of Cotton Insects, pages 27-46, in the 1953 report, have been revised and are covered in this supplement. In addition the supplement includes a brief statement on Hazards and Precautions in the Use of Insecticides.

Contents

# INSECTICIDES AND MITICIDES

## Hazards and Precautions in the Use of Insecticides

Development of new synthetic organic insecticides provides more effective means of controlling insects, but numerous problems, such as hazard to man, domestic animals, crops, fish, and beneficial wild life, have been complicated by the use of these new chemicals, although many of them are actually not as toxic to man as are some of the old insecticides. Most insecticides may be harmful to man and animals if used in excessive amounts or if handled carelessly; therefore, they should be used with appropriate precautions and in the amounts and manner recommended.

Those responsible for advocating the proper and safe use of insecticides on cotton are urged to read and become thoroughly familiar with the detailed precautions given on pages 5-9 of the 1953 Conference Report.

## Aldrin

Aldrin will control the boll weevil, thrips, the cotton fleahopper, the tarnished plant bug, the rapid plant bug, grasshoppers, the fall armyworm, and lygus bugs. It will not control the bollworm, the pink bollworm, the yellow-striped armyworm, the cotton leafworm, the garden webworm, the cotton aphid, certain species of cutworms and most other lepidopterous larvae, or spider mites. The use of aldrin may result in increased populations of spider mites, and mixtures of aldrin and DDT may increase those of aphids. For boll weevils, aldrin should be applied at the rate of 0.25 to 0.75 pound per acre. In areas or at times when bollworms are a problem, DDT should be added to aldrin in a 2:1 ratio. It is effective in a dust or spray.

Aldrin is highly toxic to man and animals and should be used with adequate precautions.

See Hazards and Precautions in the Use of Insecticides.

## Aramite

Aramite will control spider mites when applied at 0.33 to 1 pound of technical material per acre in either dusts or sprays. Two applications 5 to 7 days apart may be required to give control when the lower dosages are used. It may also be used in spray mixtures with insecticides. Aramite is compatible with sulfur, but special care should be used in the preparation of formulations. Aramite has essentially no insecticidal activity.

BHC (benzene hexachloride)

BHC will control the boll weevil, lygus bugs, the rapid plant bug, thrips, stink bugs, the garden webworm, the fall armyworm, the cotton fleahopper, and grasshoppers. It will not control the bollworm, the pink bollworm, the yellow-striped armyworm, spider mites, some species of cutworms, and the salt-marsh caterpillar. It is effective in a dust or spray. It has given erratic results against the cotton leafworm and the cotton aphid in some areas.

Except for use in early-season control, BHC is usually formulated with DDT in the ratio of 3 parts of the gamma isomer to 5 parts of DDT in both dusts and sprays for use in overall cotton-insect control. This mixture should be applied at the rate of 0.3 to 0.6 pound of the gamma isomer and 0.5 to 1 pound of DDT per acre. In some of the western areas a popular formulation has been 2 parts of the gamma isomer to 5 parts of DDT. Where spider mites are a problem, the dust usually contains at least 40 percent of a good grade of dusting sulfur. Other dusts contain either 2 or 3 percent of the gamma isomer of BHC and 10 percent of DDT. Sprays should be formulated to contain the same amounts of each active ingredient per acre as the dusts. It is very important that the emulsifiable concentrate containing BHC be properly formulated to prevent foliage or plant injury.

It is not advisable to use BHC in controlling pests on cotton which will be in rotation with root crops such as Irish potatoes, and in some areas peanuts and tobacco.

BHC is toxic to man and animals and should be used with adequate precautions.

See Hazards and Precautions in the Use of Insecticides.

Calcium Arsenate

Calcium arsenate has excellent dusting qualities and is an economical and effective insecticide for control of the boll weevil and the cotton leafworm. It is used at the rate of 7 to 10 pounds per acre. Against bollworms 12 to 15 pounds per acre will give only fair control, if applications are properly timed. Generally it is used undiluted against these insects. It often causes an increase in aphid population when used without an aphidicide. Alternate applications of calcium arsenate and a formulation containing an aphidicide have given excellent results in some areas.

Low-lime calcium arsenate is compatible with organic insecticides. In some areas when it is combined with 5 percent of DDT and 1 percent of parathion (see precautions under parathion), boll weevils, bollworms, cotton aphids, and spider mites are controlled. Low-lime calcium

arsenate in combination with these materials should be applied at the rate of 10 to 12 pounds per acre.

Calcium arsenate residue in the soil is injurious to some crops, especially legumes and oats in certain light sandy soils. It should not be used for cotton-insect control in fields where rice may be planted. Drifting of the dust may injure other crops. Precautions should be taken to avoid drift that might cause bee losses. Calcium arsenate is poisonous and should be handled carefully. Livestock should be kept out of dusted fields. Care should be taken to avoid drift onto pastures, especially when applications are made by airplane.

See Hazards and Precautions in the Use of Insecticides.

## Chlordane

Chlordane has given good results against the cotton fleahopper, the rapid plant bug, the fall armyworm, the field cricket, grasshoppers, the sand wireworm, darkling ground beetles, and thrips. Results against the boll weevil and lygus bugs have not been consistent. It will not control the bollworm, the pink bollworm, the yellow-striped armyworm, the cotton aphid, stink bugs, or spider mites.

For the insects against which chlordane is effective, from 0.2 to 2 pounds of the technical material per acre is required.

When used in mid- or late-season treatments for overall cotton-insect control, chlordane should always be formulated with DDT in a 2:1 ratio. From 1 to 1.5 pounds of technical chlordane and 0.5 to 0.75 pound of technical DDT per acre should be applied. It is effective in a dust or spray.

The populations of cotton aphids and spider mites may increase to damaging proportions after applications of chlordane-DDT sprays and dusts. Careful inspections for these pests should be made at weekly intervals after such applications. If the numbers of either increase, appropriate measures should be taken to control them as outlined under the respective pests.

Chlordane is toxic to man and animals and should be used with adequate precautions.

See Hazards and Precautions in the Use of Insecticides.

## DDT

DDT will control the bollworm, the tobacco budworm, the pink bollworm, the fall armyworm, the tarnished plant bug and other lygus bugs, the garden webworm, the cotton leaf perforator, the western yellow-striped armyworm, the beet armyworm, darkling ground beetles, flea beetles, the white-lined sphinx, the green stink bug, the southern green

stink bug, the rapid plant bug, the cotton fleahopper, the leaf roller Platynota stultana, and thrips. In some instances unsatisfactory results against thrips have been reported when the temperature exceeded 90° F. It will also control certain species of cutworms, and to a lesser extent the yellow-striped armyworm. It will not control the boll weevil, the cotton leafworm, the cabbage looper, the salt-marsh caterpillar, spider mites, the cotton aphid, stink bugs in the genera Chlorochroa, Euschistus, and Thyanta, or grasshoppers.

In a dust on cotton, DDT is ordinarily used at the rate of 0.5 to 3 pounds of technical DDT per acre, either alone or mixed with other insecticides and miticides. Sprays and dusts containing DDT are about equal in effectiveness against cotton pests.

Aphid and mite populations may increase until they cause severe injury where DDT is used, unless an aphidicide or a miticide is included in the formulation.

DDT is toxic to certain plants, such as cucurbits. Its toxicity persists as it accumulates in the soil. Therefore, it should be used only in the minimum amounts recommended for cotton-insect control, especially on light sandy soils. Contamination of adjacent crops from drift should be avoided.

DDT is toxic to man and animals and should be used with adequate precautions.

See Hazards and Precautions in the Use of Insecticides.

## Demeton (Systox)

Demeton, the principal active ingredient in Systox, is both a systemic and a contact insecticide. When applied in a foliage spray at 0.125 to 0.40 pound per acre, it is effective against cotton aphids and spider mites for 2 to 8 weeks. For soil treatment 2 to 4 pounds per acre are required, and for seed treatment 0.25 to 0.50 pound per 100 pounds of seed. It does not control the boll weevil, the bollworm, the cotton leafworm, the pink bollworm, or grasshoppers.

Demeton is a dangerous poison. It is much more toxic to warm-blooded animals than most poisons used in cotton-insect control. Therefore, it should be handled with extreme caution, and the directions prescribed by manufacturers should be strictly followed.

See Hazards and Precautions in the Use of Insecticides.

## Dieldrin

Dieldrin will control the boll weevil, thrips, stink bugs, the cotton fleahopper, lygus bugs, the rapid plant bug, the fall armyworm, grasshoppers, the variegated cutworm, the pale-sided cutworm, the granulate

cutworm, the black cutworm, the yellow-striped armyworm, field crickets, and the garden webworm. It is not effective against bollworms at the low dosages usually recommended for boll weevils. DDT should therefore be added when control of the bollworm is necessary. Spider mites and aphids may increase where dieldrin is used. Against boll weevils dieldrin should be applied at the rate of 0.15 and 0.5 pound per acre. It will kill newly hatched cotton leafworms at dosages effective against the boll weevil. It is effective either in a dust or spray.

Dieldrin is highly toxic to man and animals and should be used with adequate precautions.

See Hazards and Precautions in the Use of Insecticides.

## Endrin

Endrin in spray formulations and stabilized dusts available in 1954 were effective against the boll weevil, the bollworm, the cotton leaf perforator, the cabbage looper, lygus bugs, the brown cotton leafworm (Acontia dacia Druce), the cotton leafworm, and cutworms when applied at the rate of 0.2 to 0.5 pound per acre; against thrips and the cotton fleahopper at 0.08 to 0.15 pound. Endrin will not control spider mites or the pink bollworm. Aphids usually do not build up after its use.

The acute toxicity of endrin is considerably higher than that of dieldrin. It is toxic by skin absorption, by inhalation, and by ingestion. It is recommended for use on cotton only where persons applying it will follow the precautions prescribed by the manufacturers.

See Hazards and Precautions in the Use of Insecticides.

## Heptachlor

Heptachlor in a spray or dust will control the boll weevil, stink bugs, the garden webworm, grasshoppers, and lygus bugs at dosages ranging from 0.25 to 1.0 pound per acre. It is effective against thrips and the cotton fleahopper at dosages ranging from 0.08 to 0.25 pound per acre. Spider mite and aphid populations may increase where heptachlor or heptachlor-DDT mixtures are used. It will not control the bollworm, the yellow-striped armyworm, the pink bollworm, the cotton aphid, or spider mites.

Heptachlor is highly toxic to man and animals and should be used with adequate precautions.

See Hazards and Precautions in the Use of Insecticides.

## Lead Arsenate

For about 50 years, roughly from 1895 to 1945, lead arsenate was widely used on certain cotton insects. For use against the cotton leafworm, the bollworm, and the boll weevil it was for many years a close competitor of paris green until calcium arsenate was used in 1916. Lead arsenate is still used at times against the cotton leafworm and in baits for cutworms. In general, along with the other arsenicals, it has been replaced by organic insecticides.

## Lindane

Lindane, the essentially pure gamma isomer of BHC, may be substituted on an equivalent-weight basis for the gamma isomer of BHC in formulations used on most cotton insects. Laboratory and field tests indicate that lindane is slightly less effective than technical BHC when used for cotton aphid control.

Lindane dusted or slurried onto planting seed at the rate of 1 to 2 ounces per 100 pounds of seed will control wireworms, seed-corn maggots, and false wireworms. The use of fungicides is not covered in this report, but extensive results indicate that a suitable fungicide should be included with lindane seed treatment.

Lindane is highly toxic to man and animals and should be used with adequate precautions.

See Hazards and Precautions in the Use of Insecticides.

## Malathion

Malathion is effective against the desert spider mite, the cotton aphid, leafhoppers, whiteflies, the brown cotton leafworm, and the cotton leafworm at dosages ranging from 0.25 to 0.75 pound per acre. It has given poor results against the two-spotted spider mite.

Malathion is less toxic to warm-blooded animals than several other phosphorus compounds, but precautions should be exercised in its use.

See Hazards and Precautions in the Use of Insecticides.

## Methoxychlor

Dusts containing 10 percent of methoxychlor controlled the cotton leafworm, but lower concentrations gave poor control.

Methoxychlor gave slightly better control of the pink bollworm than DDT, but a heavy buildup of aphids usually followed its use and it failed to control bollworms. Therefore, it is not being generally used for pink bollworm control.

Methoxychlor is less effective than the insecticides now recommended for the control of the boll weevil, the bollworm, the cotton aphid, the garden webworm, spider mites, and stink bugs. It is less toxic than DDT to warm-blooded animals, and is less likely to be stored in the fat or excreted in the milk.

See Hazards and Precautions in the Use of Insecticides.

Methyl Parathion (methyl ester of parathion)

This compound was widely tested in 1952, 1953, and 1954. It will control the cotton aphid, desert spider mite, and cotton leafworm at dosages of 0.25 and 0.5 pound of the technical material per acre. At this dosage range it is also of value for boll weevil control but under heavy weevil populations and weevil migration this material does not have sufficient residual toxicity to give adequate protection under conditions of extremely high temperatures. It is not effective against the bollworm, the pink bollworm, or the two-spotted spider mite.

Methyl parathion is a dangerous poison. It is much more toxic to warm-blooded animals than most poisons used in cotton-insect control. Therefore, it should be handled with extreme caution and the directions prescribed by the manufacturers should be strictly followed.

See Hazards and Precautions in the Use of Insecticides.

Nicotine

Two percent of nicotine in calcium arsenate alternated with calcium arsenate alone will usually prevent a cotton aphid buildup, if properly applied. The period between nicotine applications should not exceed 8 to 10 days.

Three percent of nicotine at 10 to 15 pounds per acre in a suitable carrier can be used to knock out heavy aphid infestations. At least 0.3 pound per acre of free-nicotine equivalent should be applied. The source may be either nicotine sulfate or a fixed nicotine in dust form. It should be applied when the air is calm, the temperature is 75° F. or above, and preferably when there is no dew on the plants. Complete coverage is essential.

Nicotine is highly toxic to man and animals and should be used with adequate precautions.

See Hazards and Precautions in the Use of Insecticides.

## Parathion

Parathion will control the cotton aphid, some species of spider mites, the garden webworm, leafhoppers, the cotton leafworm, the brown cotton leafworm, stink bugs, and whiteflies at dosages ranging from 0.1 to 0.5 pound of the technical material per acre. Repeated applications at 1 pound per acre will control the leaf roller Platynota stultana. It may be applied in a dust or spray, alone or with other insecticides. It gives very little control of the boll weevil, the fall armyworm, the variegated cutworm, the bollworm, and the pink bollworm. Bollworm infestations sometimes increase after applications of parathion.

Parathion is a dangerous poison. It is much more toxic to warm-blooded animals than most poisons used in cotton-insect control. Therefore, it should be handled with extreme caution and the directions prescribed by the manufacturers should be strictly followed.

See Hazards and Precautions in the Use of Insecticides.

## Paris green

This arsenical was the first insecticide to be widely used on cotton. Many million pounds were used between 1870 and 1910 for the control of the cotton leafworm alone, and lesser quantities against the bollworm and the boll weevil. Although it is still used in emergencies to control the cotton leafworm, for general use on cotton it was succeeded by lead arsenate and calcium arsenate and later by organic insecticides.

## Rotenone

One percent of rotenone in calcium arsenate at each application made against the boll weevil gives satisfactory control of the cotton aphid.

## Sulfur

Sulfur has been widely used in dust mixtures on cotton for control of certain species of spider mites and the cotton fleahopper. It has a repressive effect upon aphid populations in some areas. Where the desert spider mite or strawberry spider mite is a problem, at least 40 percent of sulfur should be included in all dusts to prevent the development of damaging infestations of these species and as a depressant of the others. Sulfur is most effective when finely ground and when temperatures are 90° F. or above.

TEPP (tetraethyl pyrophosphate)

TEPP at the rate of 0.5 to 1 pint of the 40-percent concentrate per acre, or its equivalent, will control cotton aphids and some species of spider mites when used on dry plants at proper intervals. Several applications may be required for spider mite control.

This chemical deteriorates rapidly when exposed to moisture or moist air and is incompatible with alkaline materials. It should be applied immediately after being mixed with water. The residual toxicity of the chemical is very short.

TEPP is a dangerous poison. It is much more toxic to warm-blooded animals than most poisons used in cotton-insect control. Therefore, it should be handled with extreme caution and the directions prescribed by the manufacturers should be strictly followed.

See Hazards and Precautions in the Use of Insecticides.

Toxaphene

Toxaphene will control the boll weevil, the fall armyworm, the garden webworm, the cabbage looper, the tarnished plant bug, the rapid plant bug, cutworms, lygus bugs, grasshoppers, the cotton leafworm, the salt-marsh caterpillar, and the cotton leaf perforator, when applied at dosages ranging from 1 to 5 pounds of technical material per acre. Although toxaphene has been used for control of the bollworm at 2 to 4 pounds per acre and the yellow-striped armyworm at 2 to 3 pounds per acre, other materials have given more satisfactory results. It will control the cotton fleahopper and thrips when applied at 0.75 to 1 pound per acre. When properly applied, dusts and sprays are about equally effective in most areas.

Control of the bollworm, the salt-marsh caterpillar, and the cotton leaf perforator is improved where DDT applied at the rate of 0.25 to 1 pound per acre, is incorporated in the toxaphene spray. Toxaphene alone will not give adequate control of the pink bollworm. When used for the control of other insects, it has a repressive effect upon aphid populations, but not sufficient to prevent aphid outbreaks in some areas. Where spider mites are a problem, at least 40 percent of sulfur should be included in dust mixtures to prevent development of damaging infestations of sulfur-susceptible species and to serve as a depressant of other species.

Toxaphene is toxic to man and animals and should be used with adequate precautions.

See Hazards and Precautions in the Use of Insecticides.

## PROMISING INSECTICIDES AND MITICIDES RECOMMENDED FOR FURTHER EXPERIMENTATION

American Cyanamid 3911 (O,O-diethyl S-ethylmercaptomethyl dithiophosphate)

American Cyanamid 3911 is a systemic material, tested in the laboratory only. When mixed with activated carbon and applied to cottonseed at planting time at the rate of 4 pounds per 100 pounds of seed, it killed thrips, spider mites, the cotton aphid, the boll weevil, and the cotton leaf perforator for 4 to 9 weeks following emergence of the seedling plants. Seed treatments with this material may adversely affect germination and plant development.

American Cyanamid 3911 is a dangerous poison. It is much more toxic to warm-blooded animals than most poisons used in cotton insect control. Therefore, it should be handled with extreme caution and the directions prescribed by the manufacturers should be strictly followed.

See Hazards and Precautions in the Use of Insecticides.

American Cyanamid 12008 (O,O-diethyl S-isopropylmercaptomethyl dithiophosphate)

American Cyanamid 12008 is a systemic material. Preliminary tests have been conducted in both laboratory and field. When mixed with activated carbon and applied to cottonseed at planting time at the rate of 4 pounds per 100 pounds of seed, this material killed thrips, aphids, and spider mites for 4 to 6 weeks following emergence of the seedling plants. In laboratory tests the boll weevil and cotton leaf perforator were controlled for approximately 5 weeks.

When applied as a foliage spray this material showed some promise against aphids, spider mites, and thrips, but results against the boll weevil were not satisfactory. Seed treatments with this material may adversely affect germination and plant development.

American Cyanamid 12008 is a dangerous poison. It is much more toxic to warm-blooded animals than most poisons used in cotton insect control. Therefore, it should be handled with extreme caution and the directions prescribed by the manufacturers should be strictly followed.

See Hazards and Precautions in the Use of Insecticides.

Bayer L 13/59 (O,O-dimethyl 2,2,2-trichloro-1-hydroxyethyl-phosphonate)

Bayer L 13/59 was tested against cotton insects in laboratory and field-cage tests during 1953 and 1954. This material at a dosage of 0.25 to 1 pound per acre appears promising against cotton aphids, spider

mites, and cotton leafworms, as well as the boll weevil. It was ineffective against bollworms at 2 pounds per acre. Preliminary laboratory tests indicate that this compound is effective against moths of the pink bollworm.

Bayer L 13/59 is less toxic to warm blooded animals than several other phosphorus compounds, but precautions should be exercised in its use until more is known about its toxicity to man and animals.

See Hazards and Precautions in the Use of Insecticides.

Bayer 17147 (a benzotriazine derivative of a methyl dithiophosphate)

Bayer 17147 was tested by foliage application in 1954. In laboratory tests at 1 to 4 ounces per acre, it controlled the boll weevil, cotton aphid, and spider mites. Bollworms were controlled at 0.5 pound per acre. Pink bollworms were controlled in laboratory and limited field tests at 0.5 to 0.75 pound per acre. At 0.5 pound per acre it had long residual action against the boll weevil. It was ineffective against the salt-marsh caterpillar.

Bayer 17147 is a dangerous poison. It is much more toxic to warm-blooded animals than most poisons used in cotton insect control. Therefore, it should be handled with extreme caution and the directions prescribed by the manufacturers should be strictly followed.

See Hazards and Precautions in the Use of Insecticides.

Chlorthion (O-(3-chloro-4-nitrophenyl)-O,O-dimethyl thiophosphate)

Chlorthion has been effective against the boll weevil and leafhoppers at a dosage of 0.3 to 1.0 pound per acre and against the cotton leafworm, cotton aphid, and two-spotted, strawberry, and desert spider mites at 0.25 to 0.5 pound per acre. It has long residual effectiveness against the cotton leafworm. In tests conducted in Mississippi it was initially effective against thrips at 0.08 pound per acre, but the residual effect was not more than 24 hours. It was ineffective against the bollworm.

Chlorthion is less toxic to warm-blooded animals than several other phosphorus compounds, but precautions should be exercised in its use until more is known about its toxicity to man and animals.

See Hazards and Precautions in the Use of Insecticides.

Diazinon (O,O-diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl) thiophosphate)

Diazinon appears promising for the control of spider mites, cotton aphids, and leafhoppers at dosages between 0.125 and 0.5 pound per acre.

Diazinon is a dangerous poison. It is much more toxic to warm-blooded animals than most poisons used in cotton-insect control. Therefore, it should be handled with extreme caution and the directions prescribed by the manufacturers should be strictly followed.

See Hazards and Precautions in the Use of Insecticides.

Dilan (1:2 mixture of 1,1-bis (p-chlorophenyl)-2-nitropropane and 1,1-bis (p-chlorophenyl)-2-nitrobutane)

Dilan was tested against a number of cotton insects during the last several years. Small-plot tests conducted at Brownsville, Tex., in 1952 and 1953 against the pink bollworm indicated that it gave control comparable with DDT. In plot tests at Presidio, Tex., in 1954, Dilan in an emulsion spray applied at the rate of 1.5 pounds per acre at 5-day intervals and at about 3 pounds per acre at 10-day intervals gave satisfactory control of the pink bollworm. The degree of control was essentially the same as DDT applied in similar amounts at the same intervals. At Port Lavaca, Tex., in 1954 Dilan at 2 pounds per acre at 7-day intervals gave control of the pink bollworm comparable with DDT used at the same rate and intervals.

In a limited number of cage tests and field trials in Maricopa County, Ariz., satisfactory control of the salt marsh caterpillar was obtained.

In Presidio Dilan failed to control aphids and spider mites. In limited tests against the boll weevil it proved ineffective.

EPN

No work was done with EPN during 1954.

Isodrin

No work was done with isodrin during 1954.

Ovotran (p-chlorophenyl p-chlorobenzenesulfonate)

Ovotran will effectively control spider mites when applied at a rate of 2 to 3 pounds per acre. Thorough treatment and contact of the mites is essential for good control. Its initial action is slow, and it is not effective for an immediate knockdown.

Schradan (octamethyl pyrophosphoramide)

No additional data was presented on this material during 1954.

Strobane (a terpene polychlorinate with a chlorine content of approximately 66%)

The following results were obtained in 1954. In replicated experiments in South Carolina Strobane controlled the boll weevil at 2 pounds per acre both as a spray and dust. No buildup of aphids or spider mites occurred in these experiments. In Mississippi Strobane at 0.8 pound per acre in a spray was as effective as any of the recommended dosages of other materials for control of thrips. When used at the rate of 2.5 pounds per acre, good control of the boll weevil and the bollworm was obtained. In a small-scale experiment in Arizona 3 pounds per acre gave good control of lygus bugs. In field tests in Texas it was less effective against thrips and overwintered boll weevils than toxaphene when applied at comparable dosages. It was comparable to toxaphene for the control of the boll weevil and bollworm, but aphids built up to some extent following its use. In one field test against pink bollworms Strobane at 4 pounds per acre was less effective than DDT at 2 pounds.

Strobane is toxic to man and animals and should be used with adequate precautions.

See Hazards and Precautions in the Use of Insecticides.

Pyrazoxon (O,O-diethyl O-5-(3-methylpyrazolyl) phosphate)

Pyrazoxon is a systemic material. In preliminary tests, when applied at the rate of 0.25-0.5 pound per acre, it showed promise for control of cotton aphids and spider mites. It appeared to have a long period of residual control. When used at the higher rate it was only moderately effective against leafhoppers and was relatively ineffective against bollworms and Platynota stultana.

Pyrazoxon is a dangerous poison. It is much more toxic to warm-blooded animals than most poisons used in cotton insect control. Therefore, it should be handled with extreme caution and the directions prescribed by the manufacturers should be strictly followed.

See Hazards and Precautions in the Use of Insecticides.

Recommended Dosages for the Principal Insecticides and Miticides Used for the Control of Certain Cotton Pests

(Pounds per acre of technical material in a dust or emulsion spray)

| Pesticide | Boll weevil | Boll-worm | Cotton Aphid | Cotton Flea-hopper | Cut-worms | Fall Army-worm | Grass-hoppers | Lygus and Other Mirids | Cotton Leaf-worm | Spider Mites | Stink Bugs | Pink Boll-worm | Thrips |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aldrin | 0.25-0.75 | -- | -- | 0.20-0.25 | -- | 0.25-0.5 | 0.10-0.25 | 0.25-0.75 | -- | -- | -- | -- | 0.08-0.15 |
| Aramite | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.33-1.0 | -- | -- | -- |
| BHC (gamma) | 0.30-0.45 | -- | 0.3-0.6 | 0.1 | -- | 0.4-0.6 | 0.3-0.5 | 0.30-0.45 | -- | -- | 0.5 | -- | 0.1-0.2 |
| Calcium arsenate 1/ | 7-10 | 12-15 | -- | -- | -- | -- | -- | -- | 7-10 | -- | -- | -- | -- |
| Chlordane | 1.0-1.5 | -- | -- | 0.2 | -- | 1.5-2.0 | 0.5-1.5 | 1.0-1.5 | -- | -- | -- | -- | 0.5-1.0 |
| DDT | -- | 0.5-1.5 | -- | 0.5 | 1-2 | 0.5-1.5 | -- | 1.0-1.5 | -- | -- | -- | 2-3 | 0.25-1.50 |
| Demeton 2/ | -- | -- | 0.125-0.4 | -- | -- | -- | -- | -- | -- | 0.125-0.4 | -- | -- | -- |
| Dieldrin | 0.15-0.50 | -- | -- | 0.10-0.15 | 0.3-0.5 | 0.15-0.3 | 0.07-0.125 | 0.15-0.50 | -- | -- | 0.5 | -- | 0.05-0.15 |
| Endrin | 0.2-0.5 | 0.2-0.5 | -- | 0.08-0.15 | 0.2-0.5 | -- | -- | 0.2-0.5 | 0.2-0.5 | -- | -- | -- | 0.08-0.15 |
| Heptachlor | 0.25-0.75 | -- | -- | 0.2-0.25 | -- | -- | 0.25-0.50 | 0.25-0.75 | -- | -- | 1.0 | -- | 0.08-0.15 |
| Malathion | -- | -- | 0.4-0.75 | -- | -- | -- | -- | -- | 0.25 | 0.25-0.75 | -- | -- | -- |
| Methyl parathion | -- | -- | 0.25-0.5 | -- | -- | -- | -- | -- | 0.25 | 0.25-0.5 | -- | -- | -- |
| Nicotine 1/ | -- | -- | 0.30-0.45 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Parathion | -- | -- | 0.1-0.25 | -- | -- | -- | -- | -- | 0.125 | 0.10-0.4 3/ | -- | -- | -- |
| Sulfur 1/ | -- | -- | -- | -- | -- | -- | -- | -- | -- | 20-60 3/ | -- | -- | -- |
| TEPP (40%) 2/ | -- | -- | 0.5 pint | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Toxaphene | 2-3 | 2-4 | -- | 0.75-1.0 | 2-5 | 2-3 | 1.0-2.5 | 2-3 | 1.5-2.0 | -- | 6.0 | -- | 0.75-1.0 |

1/ Dust only.

2/ Spray only.

3/ Does not control all species.

## CHEMICAL CONTROL OF COTTON INSECTS AND SPIDER MITES

The principal insecticides and miticides and the recommended rates of application for the control of various cotton pests are given in the table on page 16.

### Beet Armyworm (Laphygma exigua (Hbn.))

The beet armyworm is primarily a seedling cotton pest, but may also attack older plants. Squares and blooms may be destroyed, and feeding on the bracts may cause bolls to shed. DDT at the rate of 1 to 1.5 pounds per acre is the most effective control. Toxpahene at 2 to 4 pounds per acre is also effective, but slower in action.

### Boll Weevil (Anthonomus grandis Boh.)

Variations in the effectiveness of insecticides approved for control of the boll weevil have been observed not only in local areas but during certain periods of time. The choice of insecticides will be determined by their effectiveness in the particular area where the insect is to be controlled. Dosages of technical material that have controlled the boll weevil in one or more areas are as follows:

| Insecticide | Type of Application | Pounds Per Acre |
|---|---|---|
| Aldrin | Spray or dust | 0.25 to 0.75 |
| BHC (gamma isomer) | Spray or dust | 0.30 to 0.45 |
| Calcium arsenate | Dust | 7 to 10 |
| Chlordane | Spray or dust | 1 to 1.50 |
| Dieldrin | Spray or dust | 0.15 to 0.50 |
| Endrin | Spray or stabilized dust | 0.20 to 0.50 |
| Heptachlor | Spray or dust | 0.25 to 0.75 |
| Toxaphene | Spray or dust | 2 to 3 |

However, when these insecticides are used for boll weevil control, other insect problems have to be considered. Infestations of the cotton aphid, the bollworm, the tobacco budworm, and/or spider mites may develop when some of these insecticides are used alone. Because of the particular danger of the rapid buildup of the bollworm and the tobacco budworm, DDT should always be added to aldrin, BHC, chlordane, dieldrin, and heptachlor. (For rates see under the respective insecticides or pests.) Toxaphene applications, if properly timed, will control bollworms without DDT. However, if it is used alone late in the season, careful checks should be made at 3- to 5-day intervals. If their numbers are found to be increasing, DDT should be included in subsequent applications or should be applied alone.

Aphids may build up rapidly after the use of calcium arsenate or DDT, or DDT formulated with aldrin, chlordane, dieldrin, endrin, heptachlor, or toxaphene. Spider mites may build up rapidly after the use of the last six chemicals and BHC, either when used alone or with DDT. Careful checks should be made at 5- to 7-day intervals, and if these pests are found to be increasing appropriate control measures should be started at once. (See sections on cotton aphids and spider mites.)

Insecticides should be applied for boll weevil control when definite need is indicated. Except where early-season control is practiced, applications should be made every 4 to 5 days until the infestation is brought under control. Fields should be inspected weekly thereafter and applications made when necessary.

Bollworm (Heliothis armigera (Hbn.)) and
Tobacco Budworm (H. virescens (F.))

The bollworm and the tobacco budworm are the common "bollworms" attacking cotton. Several other species of lepidopterous larvae that sometimes also cause boll injury are discussed elsewhere in this report.

It is difficult to control bollworms, and their effective control depends on the thorough and timely use of properly formulated insecticides. Frequent field inspections to determine the presence of eggs and young larvae during the fruiting period are essential. For the most effective control it is essential that insecticide applications be made before the larvae enter the bolls.

Bollworms are most effectively controlled with DDT or endrin, and in the boll weevil belt are usually satisfactorily controlled with toxaphene.

DDT should be applied at the rate of 0.5 to 1.5 pounds per acre in a dust or spray. In the Far West higher dosages may be needed. It may be used in mixtures with other insecticides where other insects also require control. It is compatible with low-lime calcium arsenate but not with regular calcium arsenate.

Endrin applied as a spray or stabilized dust at the rate of 0.2 to 0.5 pound of the technical material per acre controls bollworms. The addition of DDT to the minimum dosage will usually give more effective control.

Toxaphene at the rate of 2 to 4 pounds per acre usually controls the bollworm. It may be applied in a 20-percent dust. When toxaphene is applied as a spray the addition of DDT is desirable.

Calcium arsenate is less effective than DDT, endrin, or toxaphene.

In areas where spider mites are a problem, dusts containing organic insecticides should include at least 40 percent of sulfur or an appropriate amount of some other suitable miticide.

Cotton Aphid (Aphis gossypii Glov.)

Heavy infestations of the cotton aphid may occur on cotton after the use of certain insecticides, and on seedling cotton where no insecticides have been applied. Aphid buildup in the boll weevil areas can usually be prevented by the following treatments:

1. A dust or spray containing BHC and DDT applied at the rate of 0.3 pound of the gamma isomer and 0.5 pound of DDT per acre in every application.
2. A dust containing 3 percent of gamma BHC, 5 percent of DDT, and 40 percent of sulfur applied at the rate of 10 to 12 pounds per acre alternately with calcium arsenate.
3. Nicotine 2 percent in regular calcium arsenate dust applied at the rate of 10 to 12 pounds per acre alternated with calcium arsenate alone.
4. Parathion 1 percent in low-lime calcium arsenate dust, or added at the rate of 0.1 pound per acre to dusts or sprays of the following insecticides when these are formulated with DDT and used at the recommended rate for boll weevil control: Aldrin, dieldrin, heptachlor, and toxaphene.
5. Toxaphene at 2 to 3 pounds per acre in every application (where not formulated with DDT), in a dust or spray.

When infestations of the cotton aphid are heavy and the need for rapid kill is indicated, the following treatments are usually effective:

1. BHC or lindane in either a dust or spray to give 0.3 to 0.6 pound of gamma per acre.
2. Parathion in either a dust or spray at 0.1 to 0.25 pound per acre.
3. Nicotine 3 percent in hydrated lime dust at 10 to 15 pounds per acre.
4. TEPP in a spray at the rate of 0.5 pint of the 40-percent concentrate, or its equivalent, per acre. The effectiveness of this material is of short duration.
5. Demeton in a spray at 0.125 to 0.4 pound per acre.
6. Malathion in a dust or spray at 0.4 to 0.75 pound per acre.
7. Methyl parathion in a dust or spray at 0.25 to 0.5 pound per acre.

Cotton Fleahopper (Psallus seriatus (Reut.))

The cotton fleahopper can be controlled with the following dusts applied at the rate of 10 pounds per acre. DDT 5, toxaphene 10, dieldrin 1.5, endrin 1.0, aldrin 2.5, heptachlor 2.5, BHC gamma 1, and chlordane 2 percent. When spider mites are likely to be a problem, 40 percent or more of sulfur or an appropriate amount of some other suitable miticide should be added.

The following materials applied as low-gallonage sprays at the rates indicated per acre will control the cotton fleahopper: DDT 0.5, toxaphene 0.75 to 1, toxaphene 0.5 plus DDT 0.25, dieldrin 0.1, aldrin 0.2, heptachlor 0.2, chlordane 0.2, BHC gamma 0.1, and endrin 0.1 pound.

Cotton Leaf Perforator (Bucculatrix thurberiella Busck)

The cotton leaf perforator is at times a serious defoliator of cotton in certain areas of southern California and Arizona. It is controlled with DDT in a dust or spray at the rate of 1.5 to 3 pounds of the technical material per acre or with a dust containing 15 percent of toxaphene and 5 percent of DDT at 15 to 25 pounds of the dust per acre. Endrin at the rate of 0.2 to 0.4 pound per acre is also effective.

Cotton Leafworm (Alabama argillacea (Hbn.))

The cotton leafworm has been controlled successfully for many years with calcium arsenate, paris green, or lead arsenate. Although effective control has been obtained with a 20-percent toxaphene dust applied at 10 pounds per acre or with a spray containing 1.5 pounds of toxaphene per acre, recent investigations indicate that higher dosages may now be required. Toxaphene-DDT spray applied at the rate of 1 pound of toxaphene and 0.5 pound of DDT, or parathion at 0.125 pound in a dust or spray, and endrin at 0.2 to 0.5 pound in a dust or spray per acre have also been effective. BHC dusts containing 3 percent of gamma, alone or plus 5 percent of DDT applied at 10 pounds per acre and BHC and DDT sprays applied at 0.3 pound of gamma and 0.5 pound of DDT per acre have given effective control when used in a regular program for the control of other cotton insects. Malathion or methyl parathion as a dust or spray at 0.25 pound per acre is also effective.

Cutworms

A number of species of cutworms, including the following, may develop in weeds or crops, especially legumes, and then attack adjacent cotton or cotton planted on land previously in weeds or legumes.

Black cutworm (Agrotis ypsilon (Rott.))
Pale-sided cutworm (Agrotis malefida Guen.)
Variegated cutworm (Peridroma margaritosa (Haw.))
Granulate cutworm (Feltia subterranea (F.))
Army cutworm (Chorizagrotis auxiliaris (Grote))

Recommended control measures include thorough seed-bed preparation, elimination of weed host plants, and the use of insecticides. In western areas, irrigation of the fields forces the subterranean forms to the surface, where they may be treated with insecticides or destroyed by natural factors. If 3 to 6 weeks are allowed to elapse between the time an infested area is plowed under and the subsequent cotton crop is seeded, it may not be necessary to use insecticides.

The following sprays are effective against cutworms: Toxaphene at 2 to 4 pounds, toxaphene-DDT (2:1) at 2 to 4 pounds of total toxicant, DDT at 1 to 2 pounds, dieldrin at 0.3 to 0.5 pound, and endrin at 0.2 to 0.5 pound per acre. A dust containing 20 percent of toxaphene or 10 percent of DDT applied at 10 to 25 pounds per acre will give satisfactory control. Poison baits containing paris green, cryolite, sodium fluosilicate, toxaphene, or DDT have been satisfactory. Baits are frequently more effective than sprays or dusts against some species of cutworms.

Fall Armyworm (Laphygma frugiperda (J.E. Smith))

The fall armyworm occasionally occurs in sufficient numbers to damage cotton. The following dusts applied at the rate of 10 to 15 pounds per acre have given good control: Toxaphene 20 percent, sufficient BHC to give 3 percent of the gamma isomer plus 5 percent of DDT, or DDT 10 percent. Chlordane 10 percent at 15 to 20 pounds per acre is also effective. Toxaphene applied at 2 to 2.5 pounds or DDT at 0.5 to 1 pound per acre in sprays have given good control. Other insecticides that have been effective when applied in sprays are dieldrin 0.15 to 0.3 pound, BHC containing 0.4 to 0.6 pound of the gamma isomer, and aldrin 0.25 to 0.5 pound per acre. The results obtained from these materials have varied in different States; therefore, local recommendations are advisable. (Also see Bollworms, page 18.)

False Wireworms (Blapstinus and Ulus spp.)

Darkling ground beetles belonging to these genera occasionally affect the stand of young cotton in the western areas. The larvae may be controlled by slurrying 2 ounces of lindane with a suitable fungicide onto each 100 pounds of planting seed. Adults on young plants may be controlled with 5-percent chlordane dust at the rate of 20 pounds per acre, or with toxaphene, DDT, or toxaphene-DDT mixture (2:1) applied in sprays at the rate of 1 to 2 pounds of toxicant per acre.

Field Cricket (Acheta assimilis F.)

The field cricket occasionally feeds on cotton bolls and seedling plants in the Imperial Valley of California and in Arizona. During periods of drought late in the season the crickets may feed on the seed of open bolls, especially in the Delta sections of Arkansas, Louisiana, and Mississippi. This feeding is usually done at night by crickets that hide during the day in deep cracks in the soil. Crickets may be controlled with a 10-percent DDT or 5-percent chlordane dust applied at the rate of 20 to 25 pounds or 2.5-percent dieldrin dust at 20-30 pounds per acre. A dust containing sufficient BHC to give 2 percent of gamma plus 5 percent of DDT plus 40 percent of sulfur applied at the rate of 15 to 20 pounds per acre is also effective.

Garden Webworm (Loxostege similalis (Guen.))

The garden webworm may be controlled on cotton with the following dusts applied at the rate of 15 pounds per acre: BHC 3 percent of gamma plus 5 percent of DDT, 20 percent of toxaphene, 1 percent of parathion, or 10 percent of DDT. Good control of this insect may also be obtained with sprays containing toxaphene, toxaphene plus DDT, DDT, heptachlor, or dieldrin. DDT has given better control in sprays than in dusts, but is generally less effective than the other materials. To be most effective, control measures for this insect should be applied as soon as possible after the worms appear. After webbing becomes extensive, it is difficult to get the insecticide in contact with the insect.

Grasshoppers

Several species of grasshoppers, including the following, sometimes attack cotton:

Differential grasshopper (Melanoplus differentialis (Thos.))
Lesser migratory grasshopper (M. mexicanus (Sauss.))
Red-legged grasshopper (M. femur-rubrum (Deg.))
Two-striped grasshopper (M. bivittatus (Say))
American grasshopper (Schistocerca americana (Drury))
Lubber grasshopper (Brachystola magna (Gir.))

The American grasshopper lives overwinter as an adult, and in the spring deposits its eggs in the fields, but most other species overwinter as eggs in untilled soil, fence rows, sod waterways, around stumps, and similar locations. The species overwintering in the egg stage can best be controlled with early treatment of hatching beds before the grasshoppers migrate into the fields. Sprays or dusts containing aldrin,

chlordane, heptachlor, dieldrin, toxaphene, or BHC have largely replaced poison baits, particularly where grasshoppers must be controlled on lush or dense vegetation.

BHC sprays and dusts usually kill the grasshoppers in a few hours, but results have been erratic and residual effectiveness is limited to 1 to 2 days. Aldrin, chlordane, dieldrin, and toxaphene are very effective but slower in their action. However, they remain effective for several weeks depending on environmental conditions.

Dosages of technical material suggested to control grasshoppers come within the following ranges:

| | Pounds per Acre |
|---|---|
| Aldrin | 0.10 to 0.25 |
| BHC, gamma | 0.30 to 0.50 |
| Chlordane | 0.50 to 1.50 |
| Dieldrin | 0.07 to 0.125 |
| Heptachlor | 0.25 to 0.50 |
| Toxaphene | 1.00 to 2.50 |

The lowest dosages are effective against newly hatched to half-grown grasshoppers. The dosage should be increased as the grasshoppers mature or when the materials are applied on partly defoliated plants or on plants unpalatable to the insects.

Baits made according to State and Federal recommendations still have a place in grasshopper control, particularly in sparse vegetation.

## Lygus Bugs and Other Mirids

Several species of lygus bugs and other mirids, including the following, are often serious pests of cotton:

Tarnished plant bug (Lygus lineolaris (P. de B.))
Other lygus bugs (L. hesperus Knight and elisus Van D.)
Rapid plant bug (Adelphocoris rapidus (Say))
Superb plant bug (A. superbus (Uhl.))
Ragweed plant bug (Chlamydatus associatus (Uhl.))
Other mirids (Creontiades debilis (Van D.), C. femoralis (Van D.), and Neurocolpus nubilus (Say))

These insects cause damage to squares and small bolls of cotton and constitute a major problem, particularly in the vicinity of alfalfa fields in the irrigated areas of the West. DDT at 1 to 1.5 pounds and toxaphene at 2 to 3 pounds per acre are widely used for the control of these insects. The other organic insecticides recommended for boll weevil and bollworm control are also effective.

Pink Bollworm (Pectinophora gossypiella (Saund.))

Survival and spread of the pink bollworm over Texas and into parts of Louisiana and Oklahoma were favored by weather conditions in 1951 and 1952. These conditions likewise favored the spread into Arkansas, which first occurred in 1953, with additional findings in 1954. Heavy losses from this pest were experienced in southern Texas in 1952. Hibernation tests carried out during the winters of 1952-53 and 1953-54 proved that large numbers overwintered in northern and western Texas and southwestern Oklahoma during those mild winters. The thorough early destruction of cotton stalks in the southern portion of Texas resulted in a low carry-over during the winter of 1953-54. Although initial infestations in central Texas were generally heavier than in previous years, the drouth was unfavorable for the development of heavy general infestations in this area in 1954. However, infestations became heavy in some irrigated and other late-fruiting fields during late summer and fall. At the end of the 1954 season inspection by various methods showed distribution as indicated on map.

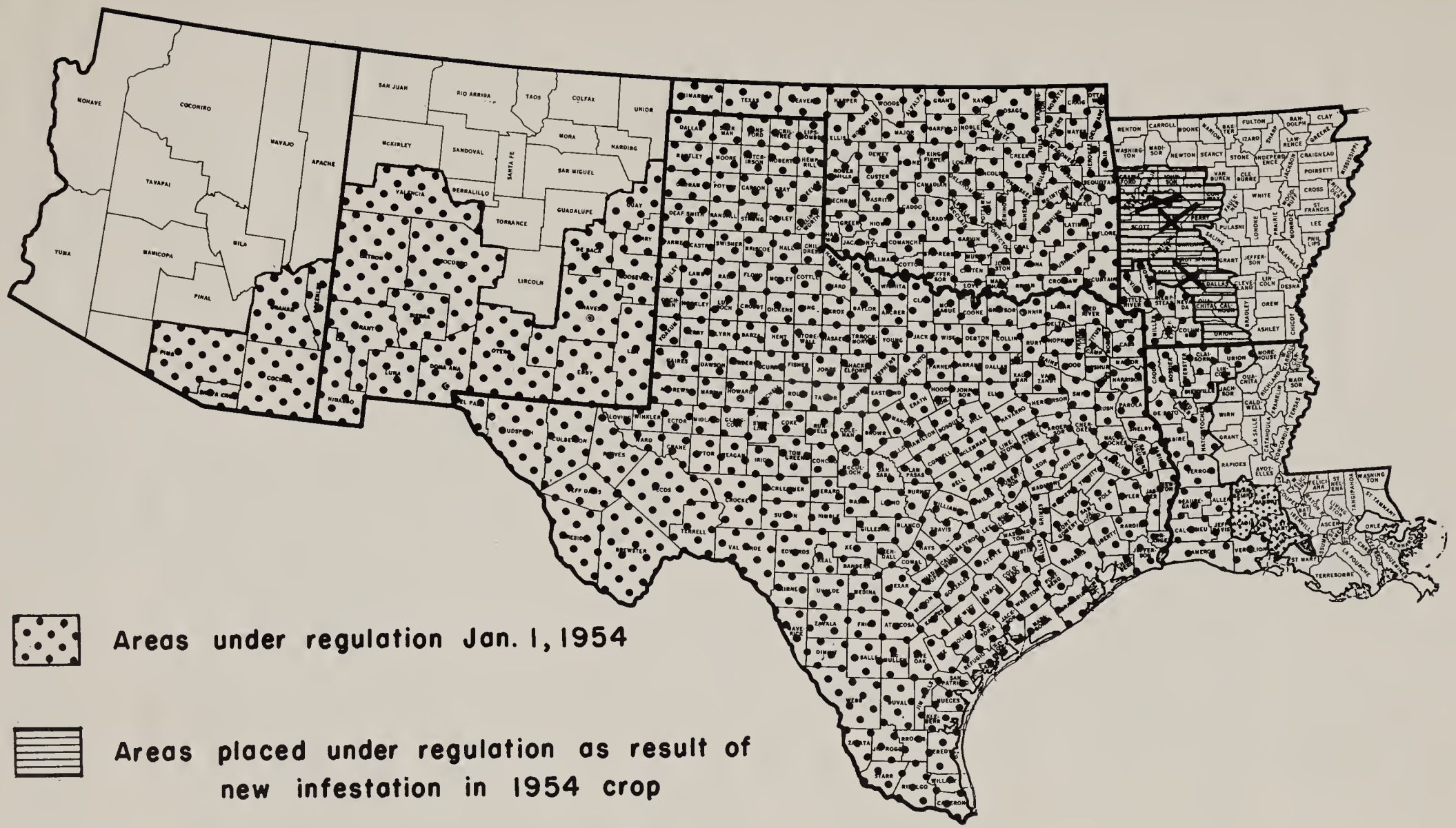
Pink bollworm infestations can usually be greatly reduced by cultural methods which entail little expense. This is the only major cotton insect that passes the winter in the larval stage primarily in the seed--in either seed cotton taken from the field or in the old bolls and locks left in the field after harvest. Quarantine requirements enforced by the States and the Federal Government insure that the seed, lint cotton, and gin trash receive treatments to kill pink bollworms they contain. Destruction of cotton stalks by deadline dates is also required in southern Texas and portions of Arkansas and Louisiana. It is recommended that these practices be rigidly observed in order to prevent a local buildup and spread of the insect to new areas. Compliance with these quarantine regulations leaves only the worms in the crop residue in the field to carry over infestation to the next crop. Fortunately, the same cultural practices recommended for controlling the pink bollworm will, to a large extent, control the boll weevil. Expensive applications of insecticides can thus be avoided and a greater profit result.

Plans for controlling the pink bollworm should be made well in advance and aimed at the production of a quick early crop. Measures that will accomplish this objective follow:

1. Plant as early in the season as is considered safe for your locality, and use seeds of an early-maturing variety that have been culled, treated with a fungicide, and tested for germination.
2. Leave as thick a stand as has been recommended for your locality and type of soil.

# PINK BOLLWORM REGULATED AREAS

## JANUARY 1, 1955




Areas under regulation Jan. 1, 1954

Areas placed under regulation as result of new infestation in 1954 crop

Released from quarantine June 22, 1954

Pink bollworm found for first time during 1954 crop season in new regulated area

3. Use insecticides to control early cotton insects such as thrips, aphids, the cotton fleahopper, the boll weevil, and cutworms, which may retard the growth and fruiting of the young plants or make replanting necessary.
4. Withhold late irrigations and use a defoliant to hasten the opening of the bolls.

The destruction of overwintering worms in the bolls and locks of cotton left in the field is the most important step in control of the pest. Remove as many bolls as possible by snapping, mechanical stripping, or heavy pasturing. Mechanical stripping has proved to be an efficient means of removing bolls where the cotton is not too rank in growth. Where these methods cannot be used and the infestation is known to be heavy, cutting, raking, and burning of the crop debris are justified.

Destroy stalks immediately after the harvest except in the cold arid areas as discussed later. Shredders are the preferred means of destroying the stalks as these kill about half the pink bollworms by mechanical action and spread the residue evenly on the ground so that it can be more thoroughly covered in the plowing operation. In hot, dry weather most of the pink bollworms will be killed if this residue is exposed to the sun for a week after shredding. In a large part of southern, central, and eastern Texas the cotton can be harvested before frost and by doing this late buildup of pink bollworms and boll weevils can be prevented. Many farmers in the southern parts of Texas and Louisiana can complete the harvest and destroy the stalks several weeks before the deadline date established by State regulations.

Where excessive rains late in the season prevent early stalk destruction, application of a desiccant will stop plant growth and a late buildup of pink bollworms and boll weevils, and will permit salvaging of part of the crop. This practice is not so effective as early stalk destruction and is recommended only as an emergency measure.

After the stalks have been destroyed, the residue should be plowed under as deeply as possible. Pink bollworm survival is highest in bolls on the soil surface and is six times as high in bolls buried only 2 inches deep as in those buried 6 inches deep. All sprout and seedling cotton developing after plowing should be destroyed before fruiting to create a host-free period between crops.

In the cold arid areas stalks should be left standing during the winter, since the highest mortality in such areas occurs in bolls on the standing stalks. In any area where water is available, fields should be winter-irrigated.

The above recommended measures are most effective when carried out on a community- or county-wide basis, and these practices will pay large dividends in savings on insecticides.

Where heavy infestations develop, crop losses from the pink bollworm can be reduced by the proper use of insecticides. The most effective material is DDT, which should be applied weekly either in a dust or spray at the rate of 2 to 3 pounds per acre. Where other insects as well as the pink bollworm require control, DDT can be mixed with other organic insecticides or with low-lime calcium arsenate. When the interval of application is reduced to 4 or 5 days for control of other insects, the quantity of DDT per application may be reduced accordingly, or to 1 to 1.5 pounds per acre in combination with the other insecticides. Thorough coverage of the cotton plants with the insecticide is essential.

The following methods of inspection should be used in determining when to start insecticide treatment for pink bollworm control:

Bloom Inspection.--After the cotton has been blooming for at least 5 days, inspect a representative number of blooms for those rosetted or infested (blooms with the petals webbed together at the tips). The inspections and estimate of the number of worms per acre should be made as follows: At five representative locations in the field, step off 300 feet down the row and then count the rosetted blooms. The total number of worms in these rosetted blooms multiplied by 10 will give the approximate number of worms per acre.

When 200 or more worms are found per acre, begin treatment immediately; when less than 200 but more than 100 worms are found per acre, begin treatment when first bolls are 20 days old; when less than 100 worms are found per acre, begin boll inspection as given below. Where treatment is required, continue until most of the bolls are open.

Boll Inspection.--Walk diagonally across the field and collect at random 100 firm speckled bolls. Remove the bracts from each boll by cutting off a small layer from the base; cut each section of the boll lengthwise (midway between the sutures) so that each lock can be removed intact; examine the inside of the boll wall for the characteristic tunnels or mines made by the small worms; also the locks should then be carefully examined for the presence of the worm. Begin treatment when 10 to 15 percent of the bolls are infested and repeat until most of the bolls are open.

Note: See pages 52 and 53 of the 1953 Report for additional pink bollworm inspection methods.

Seed-Corn Maggot (Hylemya cilicrura (Rond.))

The seed-corn maggot may seriously affect the stand of cotton, particularly when planting closely follows the turning under of a green manure crop or other heavy growth. This insect may be controlled

with 1 to 2 ounces of lindane in a wettable powder mixed with a suitable fungicide and applied onto each 100 pounds of planting seed. Seed should be treated immediately before planting.

Spider Mites

The following spider mites are known to attack cotton:

Strawberry (Atlantic) spider mite (Tetranychus altanticus McG.)
Two-spotted spider mite (T. telarius (L.) = bimaculatus Harvey)
Four-spotted spider mite (T. canadensis (McG.))
Desert spider mite (T. desertorum Banks)
Pacific spider mite (T. pacificus McG.)
Schoene spider mite (T. schoenei McG.)
Tumid spider mite (T. tumidus Banks)
Brown wheat mite (Petrobia latens (Mueller))

These species differ in their effect on the cotton plant and in their reaction to miticides. Accurate identification of the species is essential. The use of organic insecticides for cotton-insect control has been a factor in the changing importance of these pests.

The two-spotted spider mite is the most difficult species to control on cotton. It occurs as the green form in many areas and as the carmine subspecies (T. t. multisetis (McG.)) in the South and in southern California. Both forms can be controlled with demeton at 0.125 to 0.4, Aramite at 1, and Ovotran at 2 to 3 pounds per acre. Parathion at 0.2 to 0.4 pound per acre is also effective in some localities.

The Pacific spider mite is restricted to the Pacific coast, where it has been a major pest of cotton. Sulfur at 60, demeton at 0.25 to 0.40, Ovotran at 2 to 3, and Aramite at 1 pound per acre give effective control of this species. The other organic phosphorus compounds are not satisfactory.

The strawberry (Atlantic) spider mite first attacks the lower leaves of the plant and causes severe defoliation. Demeton at 0.25 to 0.40, Ovotran at 2 to 3, Aramite at 1, and sulfur at 20 to 25 pounds per acre will control this mite.

The desert and tumid spider mites are controlled with sulfur at 20 to 25, parathion at 0.1 to 0.25, methyl parathion at 0.25 to 0.5, malathion at 0.25 to 0.75, and Aramite at 0.3 to 0.75 pound per acre.

The brown wheat mite may attack seedling cotton in the Far West. Parathion at 0.3 pound and sulfur at 25 to 30 pounds per acre during warm weather will control this species.

In some areas where mites are a problem, they may be controlled by including a suitable miticide at a comparatively low rate in all insecticide applications. For control of some species and suppression

of others at least 40 percent of sulfur may be incorporated in dusts. Elemental sulfur cannot be incorporated in sprays applied at low gallonage. Other miticides may be substituted. Sulfur dust is most effective when finely ground and when applied at temperatures above 90° F. Thorough coverage is essential for effective results in the use of miticides.

## Stink Bugs

The following stink bugs are sometimes serious pests of cotton:

Conchuela (Chlorochroa ligata (Say))
Say stink bug (C. sayi Stal.)
Southern green stink bug (Nezara viridula (L.))
Green stink bug (Acrosternum hilare (Say))
Brown cotton bug (Euschistus impictiventris Stal.)
Brown stink bug (E. servus (Say))
(also E. variolarius (P. de B.), tristigmus (Say), and conspersus Uhl.)
Red-shouldered plant bug (Thyanta custator (Fab.))
(also T. rugulosa (Say), brevis Van D., and punctiventris Van D.)

The importance of these pests and the species involved varies from year to year and from area to area. The damage they cause is confined principally to the bolls and results in reduced yields and lower quality of both lint and seed. Dieldrin and gamma BHC at 0.5 pound and heptachlor at 1 pound per acre give control of these stink bugs. Toxaphene at 6 pounds per acre gives fair to good control and is sometimes preferred where a bee hazard is involved. A 5-percent DDT dust at 20 pounds per acre will control the southern green stink bug and green stink bug.

A dust containing sufficient BHC to give 2 percent of gamma, 5 percent of DDT, and 50 percent of sulfur applied at 15 to 30 pounds per acre also gives control of stink bugs, lygus bugs, bollworms, and cotton aphids, and is widely used for the control of these pests in the western areas.

## Thrips

Thrips often cause injury to cotton seedlings, especially in areas where vegetables, legumes, and small grains are grown extensively. The following species have been reported as causing this injury:

Tobacco thrips (Frankliniella fusca (Hinds))
Flower thrips (F. tritici (Fitch))
(also F. runneri (Morg.), exigua Hood, and occidentalis (Perg.))

Onion thrips (Thrips tabaci Lind.)
(also Sericothrips variabilis (Beach))

In some areas cotton plants usually recover, so that control is not recommended unless the stand is threatened. In other areas thrips damage is more severe than is generally realized. The destruction of leaf tissue and subsequent slowing of plant growth may make the seedlings more susceptible to diseases. Injury by thrips alone or the combined injury of thrips and disease may reduce or even destroy stands of young plants. A heavy infestation may retard plant growth and delay fruiting and crop maturity. Although thrips are predominantly pests of seedling cotton, damaging infestations sometimes occur on older cotton in certain areas.

The following insecticides and pounds per acre applied as sprays or dusts will control thrips and are recommended when the situation warrants their use: Toxaphene 0.75 to 1; BHC gamma 0.1 to 0.2; BHC gamma 0.15 plus DDT 0.25; aldrin, endrin, and heptachlor 0.08 to 0.15; dieldrin 0.05 to 0.15; chlordane 0.5 to 1; DDT 0.25 to 1.5. DDT has not given satisfactory control at temperatures above 90° F. Sprays are more effective than dusts on seedling cotton. When applications are made by airplane, the dosages mentioned above should be increased by at least 50 percent.

Parathion, methyl parathion, and chlorthion are effective against thrips but are not generally recommended because their residual toxicity is of shorter duration that that of insecticides usually used for thrips control.

The bean thrips (Hercothrips fasciatus (Perg.)) is a common mid-season pest of cotton in parts of California. DDT at 1 pound or toxaphene at 2 to 3 pounds per acre gives satisfactory control when applied in either a spray or dust.

White-fringed Beetles (Graphognathus leucoloma (Boh.),
peregrinus (Buch.), and minor (Buch.))

White-fringed beetles are pests of cotton and many other farm crops in limited areas of Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. The larvae feed on the roots of young plants. These insects can be controlled by the use of good cultural practices and insecticides. Recommended cultural practices include the following:

1. Plant oats or other small grains in heavily infested areas.
2. Restrict planting of summer legumes, such as peanuts, soybeans, velvetbeans, or other favorable host plants of the adult beetles to not more than one-fourth of the total crop land. Do not plant these crops on the same land more often than once in 3 or 4 years.

3. Do not intercrop corn with peanuts, soybeans, crotolaria, or velvetbeans. Prevent the growth of broadleaved weeds such as cocklebur and sicklepod.
4. Improve poor soils by turning under winter cover crops.

DDT is effective against white-fringed beetle larvae. Apply 15 pounds of DDT per acre (30 pounds of 50 percent DDT or 60 pounds of 25 percent DDT). Distribute it evenly over the soil surface in a dust, spray, or mixed with sand. Thoroughly mix it into the upper 3 to 4 inches of soil by disking the land twice prior to planting. This treatment will give control of the larvae for at least 4 years. DDT may also be used in the drill before or at the time of planting at the rate of 2.5 to 5 pounds per acre. Mix it with sand or with fertilizer and apply by hand or with a fertilizer distributor, at or slightly below the depth of seed planting.

Chlordane will also control white-fringed beetle larvae, and has the advantage of controlling several other soil pests at the same time. Apply 1 to 2 pounds per acre in the drill before or at the time of planting in the same way as DDT, either mixed with sand or with the fertilizer. Drill-row applications of chlordane must be renewed each year.

Either toxaphene or a BHC-DDT mixture applied on cotton foliage gives a residue in the soil which aids in the control of white-fringed beetles. These insecticides should be used for control of the cotton insects for which they are recommended in white-fringed beetle infested areas.

Experimental data indicate that dieldrin at 1 to 2 pounds and aldrin and heptachlor at 2 to 3 pounds per acre, applied to crop land and worked into the soil, will give good control of the white-fringed beetle.

White-lined Sphinx (Celerio lineata (F.))

The white-lined sphinx occasionally occurs in uncultivated areas in large numbers and migrates to cotton fields. It may be controlled on cotton with DDT at 1 to 1.5 pounds or toxaphene at 2 to 3 pounds per acre in a dust or spray. Migrations may be stopped by barrier strips of 10-percent DDT or 20-percent toxaphene or by physical barriers.

Whiteflies (Trialeurodes abutilonea (Hald.) and vaporariorum Westw.)

Whiteflies are usually kept in check by parasites and diseases, but occasionally may be serious late in the season. Parathion at 0.125 to 0.5 or malathion at 0.25 to 0.75 pound per acre is effective against these insects, but repeated applications may be necessary.

## Wireworms

Several species of wireworms are associated with cotton. Damage is caused by the sand wireworm (Horistonotus uhlerii Horn.) in South Carolina, Louisiana, and Arkansas and by the Pacific Coast wireworm (Limonius canus Lec.) in California. Adults of the tobacco wireworm or spotted click beetle (Conoderus vespertinus (F.)) are frequently found on the cotton plant, but the amount of damage the larvae cause to cotton is not known. Wireworms together with false wireworms and the seed-corn maggot sometimes prevent the establishment of a stand. To control these insects, the seed should be treated with 1 to 2 ounces of lindane with a suitable fungicide per 100 pounds in a slurry.

Approved crop-rotation practices, increased soil fertility, and added humus help to reduce damage to cotton by the sand wireworm. Aldrin, chlordane, dieldrin, heptachlor, DDT, and BHC have shown promise in the control of this and other wireworms on other crops. Additional research on the control of wireworms attacking cotton is needed.

## Yellow-striped Armyworm (Prodenia ornithogalli Guen.), and the Western Yellow-striped Armyworm (P. praefica Grote)

These insects sometimes cause considerable damage to cotton. The yellow-striped armyworm is difficult to kill with insecticides. EPN at 0.3 pound per acre applied in an emulsion spray was superior to any of the chlorinated hydrocarbons. However, toxaphene at 2.5 pounds, DDT at 1 pound, and dieldrin at 0.3 pound per acre in an emulsion spray gave fair control when used in the early stages of worm development. Dieldrin in a 3-percent dust and toxaphene in a 20-percent dust applied at 15 pounds of dust per acre also gave good kills of both large and small yellow-striped armyworms.

The western yellow-striped armyworm, which attacks cotton in California, is easily controlled with DDT at 1 to 1.5 pounds or toxaphene at 2 to 3 pounds per acre applied in a dust or spray. Migrations from surrounding crops may be stopped by barriers of 10-percent DDT or 20-percent toxaphene at 2 to 4 pounds per 100 feet.

## Miscellaneous Insects

The brown cotton leafworm (Acontia dacia Druce) was collected on cotton in Austin, Robertson, and Wharton Counties, Tex., in 1953, but no damaging infestations were found. Injurious infestations occurred on several thousand acres of cotton in the Brazos River bottom of Brazos, Burleson, and Robertson Counties and on a few hundred acres in each of Wharton and Matagorda Counties in July 1954. Light

infestations were found in Natchitoches and Red River Parishes, La., in October 1954. Adults were collected in a light trap at Natchitoches in August 1954. Laboratory and field tests conducted at College Station, Tex., and commercial use showed that this pest may be controlled with parathion at 0.125 pound, malathion at 0.25 pound, and endrin at 0.33 pound per acre. Toxaphene, DDT, BHC, cryolite, and calcium arsenate were ineffective at dosages recommended for the control of other cotton insects.

The cabbage looper (Trichoplusia ni (Hbn.)) and related species occasionally cause damage to cotton in localized areas. Dusts containing 20 percent of toxaphene at 10-15 pounds or 5 percent of DDT plus 15 percent of toxaphene at 20 to 30 pounds per acre are effective. Sprays containing toxaphene at 2 to 3 pounds, endrin at 0.25 to 0.50 pound or DDT at 1.5 pounds plus toxaphene at 3 pounds per acre are also effective.

The greenhouse leaf tier, also known as the celery leaf tier (Phlyctaenia rubigalis (Guen.)), became extremely abundant on cotton in the San Joaquin Valley in 1954. Despite the heavy populations, damage was generally slight and restricted to foliage on the lower third of the plants in lush stands. In a few places it was necessary to control this pest, and a dust containing 5 percent of DDT plus 10 to 15 percent of toxaphene at 25 to 35 pounds per acre gave satisfactory control.

The corn silk beetle (Luperodes brunneus (Crotch)) has been reported as a pest of cotton in localized areas in several States but little is known about it.

Cotton root aphids: The species of root aphids known to attack cotton are the corn root aphid (Anuraphis maidi-radicis (Forbes)), and Trifidaphis phaseoli (Pass.), and Rhopalosiphum subterraneum Mason. So far as is known, injury by root aphids to cotton is confined to the eastern seaboard. Several species of ants are known to be associated with root aphids, the principal one being the cornfield ant (Lasius alienus americanus Emery). Chemical control of root aphids has been directed at the control of this ant. Some of the new materials are known to be effective as soil insecticides, and it is suggested that they be tested against root aphids attacking cotton. Root aphids injure cotton chiefly in the seedling stage. Since cotton in this stage often shows signs of injury without any evidence of insects being present, it is suggested that careful examinations of the underground portions be made to determine the possibility of root aphid attack. Ant mounds at the base of seedling plants indicate the presence of root aphids.

The cotton square borer (Strymon melinus (Hbn.)) occurs throughout the Cotton Belt, but rarely causes economic damage. The injury this insect causes to squares is often attributed to the bollworm.

The cotton stainer (Dysdercus suturellus (H.-S.)) is found within the United States in Florida only. However, probably owing to mistaken identity, the literature also records it from Alabama, Georgia, and South Carolina. No work on control has been formally reported in recent years, but observations indicate that dusts containing 10 percent of toxaphene or BHC 1 percent gamma will control insects of this genus. Indications are that DDT may also be effective.

The cotton stem moth (Platyedra viella Zell.), a close relative of the pink bollworm, was first discovered in the United States in 1951, when larvae feeding in hollyhock seed at Mineola, Long Island, N. Y., were collected by J. H. Mahaney, and determined by H. W. Capps of the Bureau of Entomology and Plant Quarantine. It is recorded as a pest of cotton in Iran, Iraq, Morocco, Transcaucasia, Turkestan, and U.S.S.R., and as feeding on hollyhock and other malvaceous plants in England, France, and central and southern Europe. Collections made in 1953 extended its known distribution in this country to a large part of Long Island and to limited areas in Connecticut and Massachusetts. Extensive scouting during 1954 disclosed that it has now reached 11 counties in 4 States as follows: Connecticut: Hartford and New Haven; Massachusetts: Essex and Plymouth; New Jersey: Monmouth, Ocean, and Union; New York: All counties of Long Island (Nassau, Queens, and Suffolk) and Westchester. Although this species has not been found on cotton in the United States, it is mentioned here because of the desirability of keeping on the lookout for it on cotton, hollyhock, and other malvaceous plants.

The cowpea aphid (Aphis medicaginis Koch), the green peach aphid (Myzus persicae (Sulz.)), and the potato aphid (Macrosiphum solanifolii (Ashm.)) are common on seedling cotton. Cotton is not believed to be a true host of these species.

The cowpea curculio (Chalcodermus aeneus Boh.) sometimes causes damage to seedling cotton.

Flea beetles.--The pale-striped flea beetle (Systena blanda Melsh.), the elongate flea beetle (S. elongata (F.)), and S. frontalis (F.) sometimes cause serious damage to seedling cotton in some areas. They can be controlled with chlordane at 0.5 pound, aldrin at 0.25 to 0.5 pound, dieldrin at 0.25 to 0.33 pound, DDT at 1 pound, or toxaphene at 2 to 3 pounds per acre in dusts or sprays. The sweetpotato flea beetle (Chaetocnema confinis Crotch) was found injuring seedling cotton in the Piedmont section of South Carolina during May 1954. Other species of flea beetles have been reported from cotton, but records regarding the injury they cause are lacking. When flea beetle injury to cotton is observed, collections of the insects should be submitted to specialists for identification with a statement regarding the nature and extent of damage they cause, the locality, and the date of collection.

The grape colaspis (Colaspis flavida (Say)) is widespread and is often found on cotton near the base of squares and bolls where it feeds on the bracts surrounding them, causing a characteristic type of injury.

Several leafhoppers of the genus Empoasca are abundant on cotton, but only two, solana and fabae, cause serious injury. These species are known to be phloem feeders on some crops and cause damage typical of this type of feeding on cotton. In the San Joaquin Valley of California where the potato leafhopper E. fabae occurs, satisfactory control has been obtained with 1 to 1.5 pounds of DDT per acre. In the desert areas where solana occurs, parathion at 0.25 to 0.5 or malathion at 0.75 pounds per acre have given satisfactory results. Perthane at 1.5 pounds per acre shows considerable promise.

Several of the leaf rollers (Tortricidae) occasionally damage cotton. Platynota stultana (Wlsm.) and rostrana (Wlkr.) are the species most commonly recorded, but flavedana Clem. and idaeusalis (Wlkr.) have have also been reported. These species are widely distributed and have many host plants. P. stultana was a serious pest of cotton in the Imperial Valley of California and parts of Arizona and New Mexico in 1954. DDT at 2 to 3 pounds per acre and parathion at 1 pound per acre were the most promising of the materials tested.

The pink scavenger caterpillar (Pyroderces rileyi Wlsm.) is one of several insects which resembles the pink bollworm. The larva is primarily a scavenger in cotton bolls and corn husks where other causes have produced the initial injury. It is sometimes mistaken by laymen as the pink bollworm.

The salt-marsh caterpillar (Estigmene acrea (Drury)) can be controlled with toxaphene applied in either a dust or a spray at the rate of 3 pounds per acre, preferably when the worms are small. If the worms are large 4 to 5 pounds per acre are required. A dust or spray containing DDT plus toxaphene in a 1:3 ratio applied at 4 to 6 pounds of toxicant per acre or a spray of endrin at 0.2 to 0.5 pound per acre is effective. When dusts are used they should contain at least 40 percent of sulfur. In laboratory and limited field tests Dilan has shown considerable promise for the control of this insect.

The serpentine leaf miner (Liriomyza subpusilla (Frost)) infested cotton in large numbers in some fields in Texas during 1953 and 1954. Drouth conditions favor development of infestations of the pest on this crop. Heavy infestations may result in considerable leaf shed. Field tests conducted at Waco, Tex., showed that the best reductions were obtained with parathion at 0.25 pound per acre; in some tests good reductions were obtained with chlorthion at 0.25 to 0.5 pound. Dieldrin, toxaphene, endrin, heptachlor, and DDT used at dosages generally recommended for the control of other cotton insects were ineffective.

The stalk borer (Papaipema nebris (Guen.)) is widely distributed east of the Rocky Mountains. It attacks many kinds of plants including cotton and is so destructive that one borer in a field may attract attention. They are most likely to be noted near the edges of the cotton fields. Clean

cultivation and keeping down weed growth help to hold them in check. The use of stalk shredders early in the fall should reduce their numbers. Information is needed concerning the effectiveness of chemicals for the control of this insect.

Occasionally the yellow woollybear (Diacrisia virginica (F.)) and the hairy larvae of several other tiger moths (Arctiidae), including Callarctia phyllira (Drury), arge (Drury), and oithona Strk., cause serious damage to cotton. Information is needed in regard to their seasonal host plants, distribution, natural enemies, causes of serious outbreaks in cotton fields, life history, and control. Determinations by specialists should always be obtained.

## CONFEREES AT EIGHTH ANNUAL CONFERENCE

One hundred entomologists and associated technical workers concerned with cotton-insect research and control participated in this conference. They were from the agricultural experiment stations, extension services, and other agencies in 15 cotton-growing States, the United States Department of Agriculture, and the National Cotton Council of America. The statements in this supplement were agreed upon and adopted by the following conferees:

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